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Original Article

Lipotropic capacity of raw plant-based foods: A new index that reflects their lipotrope density profile

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ABSTRACT

Among all of the phytomicronutrients, lipotropes which limit excess hepatic fat deposits, have been very little studied. And yet, liver steatosis is common to several chronic diseases. Among the lipotropes, betaine, choline, *myo*-inositol, methionine, magnesium, niacin, pantothenic acid and folates were the ones for which sufficient data have possibly been found to allow the selection of a significant number of plant-based foods (PBFs). Our objectives were to unravel the differences or similarities in the lipotrope density (LD) profile of raw PBFs and to define an index reflecting lipotrope contents. From databases for betaine and choline contents, we selected 56 raw PBFs (38 when inositol content was taken into consideration). Lipotropic capacity (LC) was defined as the means of the 8 LD profiles, each expressed as a percentage of raw asparagus LD, which has the highest mean ranking for the 8 LDs (LC = 100). LCs ranged from 7 (grapes) to 672% (spinach), relative to asparagus LC. Among cereal, fruit, legume and seed groups, quinoa, blackberry, common bean and sesame seed had the highest levels of LC (155%, 107%, 36% and 26%, respectively). On a 100 kcal-basis, vegetables are the best sources of lipotropes, followed by cereals, fruits and legumes, then nuts and seeds. PBF LD profiles were complementary but more diversified compared to animal-based food LD profiles.

1. Introduction

Increased consumption of unrefined plant-based food (PBFs) tends to be associated with a reduced risk of developing cancers, cardiovascular diseases, type-2 diabetes and overweight/obesity (Fardet and Chardigny, 2011). The reason lies in the high density of their bioactive compounds, mainly fibre compounds, vitamins, minerals, oligo-elements and associated phytochemicals such as carotenoids, polyphenols, terpenoids, alkaloids and nitrogen compounds. Their antioxidant, hypolipidaemic, hypoglycaemic, anti-carcinogenic and/or anti-inflammatory properties are among their most studied physiological effects in animals and/or *in vitro*, and secondarily in humans.

Another physiological property that is common to several phytochemicals is the ability to counteract the development of fatty liver or hepatic steatosis, called the "lipotropic effect". *Sensu stricto*, a lipotrope prevents the liver from excess fat deposits by hastening fat removal, limiting fat uptake, increasing fatty oxidation and/or reducing fatty acid and triglyceride synthesis. The main physiological mechanisms by which lipotropes act *in vivo* have been described in a previous review (Fardet and Chardigny, 2011). Briefly, they involve methyl donation for methionine synthesis to favour hepatic phospholipid synthesis, these latter being constitutive of VLDL/LDL that export excess triglycerides outside the liver. The reduction of lipogenic enzyme activities and activation of fatty acid oxidation enzymes are also implicated. In addition, the gene expression of PPARα (peroxisome proliferator-activated receptor) and SREBP (sterol regulatory element binding proteins), which both play a role in lipid metabolism regulation, may be, respectively, up- and down-regulated (Fardet and Chardigny, 2011).

Hepatic steatosis may result from several nutritional imbalances related to excess alcohol (Lieber, 1997), obesity/overweight and diabetes (Silverman et al., 1989) and has been associated with a cluster of different impaired physiological mechanisms, like insulin resistance (Gastaldelli et al., 2009), increased oxidative stress (Kwon et al., 2009), hyperlipidaemia (Vuppalanchi and

Abbreviations: ABF, animal-based food; BeChIMe, acronym for the sum of betaine, choline, myo-inositol and methionine; GI, glycaemic index; HC, hierarchical classification; IP, *myo*-inositol phosphates; IP6, *myo*-inositol hexakisphosphate (or phytic acid); LC, lipotropic capacity; LD, lipotrope density; NAFLD, non-alcoholic fatty liver disease; PAI, potentially available *myo*-inositol; PBF, plant-based food; PCA, principal component analysis; RS, resistant starch; TI, total *myo*-inositol; TPC, total phenolic compounds; USDA, United States Department of Agriculture.

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